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SHORT COMMUNICATION: THE INFLUENCE OF VERMICOMPOST BASED SUBSTRATES ON BASIL GROWTH AND NUTRIENT CONTENT

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ABSTRACT. Vermicompost produced by earthworms is rich in macro- and micronutrients, vitamins and growth hormones, which are all needed for successful plant growth. The influence of vermicompost based growth substrates on basil (*Ocimum basilicum* L.) growth and nutrient content was assessed. Treatments were: 1. 30% vermicompost, peat, sand, dolomite stone; 2. 25% vermicompost, peat, gravel, perlite; 3. 25% vermicompost, peat, gravel, light gravel, 4. commercially available growth medium, or 5. 20% vermicompost and organic matter rich clay soil. Basil growth was best with treatments 1 and 2. Nutrient content of basil was best in treatment 3. The best growth substrate for basil production is treatment 1, based on growth results, while based on nutrient analysis when basil is used in medicine, the right treatment is 3: 25% vermicompost, peat, gravel, light gravel.

Introduction

Vermicomposting is the "bioxidation and stabilization of organic material involving the joint action of earthworm and mesophilic microorganisms" (Barik *et al*., 2011). Vermicompost produced by earthworms is rich in macro- and micronutrients, vitamins, growth hormones, the enzymes protease, amylase, lipase, cellulase and chitinase, and immobilized microflora (Barik *et al*., 2011).

Disposal of organic wastes from domestic, agricultural and industrial sources has caused increasing environmental and economic problems and technologies to address this problem have been developed (Dominguez, Edwars, 2004). The use of earthworms to convert waste to a useful product has been established (Adhikary, 2012).Worm casting (also known as worm cast or vermicast) is a biologically active material containing bacteria, enzymes, and remnants of plant materials not digested by worms. Castings contain slow released nutrients that are readily available to plants.

Advantages of castings are:

1. They have high plant growth regulating activity.
2. The ability to develop biological resistance in plants.
3. The ability to minimize pests attack.
4. The ability to suppress plant disease.
5. The possibility to produce Vermimeal.

Vermicompost reduced amount of water for irrigation, reduced pest attack, reduced termite attack in farm soil, reduced weed growth, increased the time of seed germination, improved seedling growth and development, improved the number of fruit per plant (in vegetable crops), and improved taste and texture of vegetables (Sinha *et al*., 2009).

The purpose of the work was to assess the influence of vermicompost based growth substrates on basil (*Ocimum basilicum* L.) growth and nutrient content. It was important because of vermicompost produced by earthworms is rich in macro- and micronutrients, vitamins and growth hormones, which are all needed for successful plant growth.

Materials and Methods

The experiments were carried from December 2015 to February 2016 a glass greenhouse belonging to K. Compos company. The green basil cv. Genovese was used.

Treatments were with proprietary products [K. Compos company (Kõmsi tee 17, Kõmsi küla, Hanila vald, Läänemaa 90102, Estonia)] under brand name USSIMO (www.ussimo.eu) but generally comprised of:

1. 30% vermicompost, peat, sand, dolomite stone;
2. 25% vermicompost, peat, gravel, perlite;

3. 25% vermicompost, peat, gravel, light gravel;
4. locally, commercially available, growing medium containing peat, chicken manure and wood;
5. 20% vermicompost and organic matter rich clay soil.

Company K. Compos do not want to give accurate recipes as it remains their property right. The composition of the growing mixes were determined (Table 1). The Nitrogen is determined according to Kjeldahl in soil (Tecator ASN 3313 AOAC 2001.11). The available Phosphorus is determined in soil by Flow Injection Analysis (AL method). From the same solution, the available Potassium is determined in soil by Flame Photometric Method (AL method). The Magnesium is determined in soil by Flow Injection Analysis (Tecator ASTN 90/92). From the same solution, the available Calcium is determined in soil by Flame Photometric Method. Organic matter is determined by loss on ignition method. The pH of the soil is determined in a 1 N KCL solution. Soil and solution ratio 10 g : 25 ml.

Table 1. Analyses of substrates used for treatments

Treatment[a]	pH_{KCl}	N (%)	P ($mg \cdot kg^{-1}$)[b]	K ($mg \cdot kg^{-1}$)[b]	Ca ($mg \cdot kg^{-1}$)	Mg ($mg \cdot kg^{-1}$)	Organic matter (%)
1	6.56	1.005	2689.2	5029.1	2656.5	2193.6	29.61
2	6.79	0.305	684.0	2423.4	2303.3	572.2	11.80
3	6.48	0.370	859.3	2638.2	2131.4	626.0	13.53
4	5.58	0.968	936.3	2478.6	4887.1	1066.2	76.44
5	6.71	0.690	1347.1	2469.2	2691.7	792.3	12.68

[a] 1 – 30% vermicompost, peat, sand and if needed dolomite stone; 2 – 25% vermicompost, peat, gravel, perlite; 3 – 25% vermicompost, peat, gravel, light gravel; 4 – locally available, proprietary growth substrate, 5 – 20% vermicompost and organic matter rich clay soil.
[b] AL-method.

Seed were sown in 5 boxes with each treatment in 1 box. Boxes were 40×25 cm. In each box were 4 rows (those were replications), each row consisted of 8 plants (plants per one replication). The first experiment was sown on 5 December 2015 into each medium and plants harvested on 3 January 2016. Seed in the second experiment were sown on seven of January 2016 and plants harvested on 2 of February 2016.

Plants were grown with continuous light from high-pressure sodium lamps with light intensity of 380 lumens. A minimum day and night temperature of 23–24 °C was maintained. Ten plants in each replication were used for measurements. At the end of experiments shoot, height and root lengths were determined and number of leaves counted. Nitrogen content was determined according to the Copper Catalyst Kjeldahl Method (984.13). Phosphorous determination was carried through in Kjeldahl Digest by Fiastar 5000 (AN 5242; Stannous Chloride method, ISO/FDIS 15681). Potassium determination was with flame photometry (956.01). Calcium content was with the o-Cresolphthalein Complexone method (ISO 3696, in Kjeldahl Digest by Fiastar 5000). Magnesium determination was by Fiastar 5000 (ASTN90/92; Titan Yellow method).

Analyses of variance were carried out on the data obtained using the programme Agrobase. Fisher's LSD test was run on data.

Results

Treatment affected shoot and root lengths, and numbers of leaves (Table 2). Shoot and root lengths were shortest in treatment 5. The most leaves were produced in treatments 1 and 2. Nutrient content was affected differently by treatment (Table 3). The content of nitrogen was lowest in treatment 2; phosphorus content was not affected by treatment; potassium was highest in treatments 1 and 3, and lowest in treatment 5; calcium was lowest in treatments 1 and 2 and highest in treatments 4 and 5, and magnesium was lowest in treatment 2 and highest in treatments 3 and 5.

Table 2. Lengths of roots and shoots (cm), and number of leaves of basil as affected by treatment.

Treatment[a]	Root length		Shoot length		Number of leaves	
	average	s[b]	average	s	average	s
1	6.8	1.7	7.3	1.2	5.9	0.4
2	6.5	1.4	5.9	1.1	5.9	0.8
3	6.1	1.9	6.9	1.5	5.4	0.9
4	6.1	1.2	5.6	1.2	4.7	1.0
5	3.8	1.0	3.5	0.9	4.0	0.2
p	***		***		***	
LSD (P = 0.05)	2.77		1.96		0.03	

Used sign: *** p<0.001.
[a] 1 – 30% vermicompost, peat, sand and if needed dolomite stone; 2 – 25% vermicompost, peat, gravel, perlite; 3 – 25% vermicompost, peat, gravel, light gravel; 4 – Locally available, proprietary growth substrate, 5 – 20% vermicompost and organic matter rich clay soil).
[b] s – standard deviation.

Table 3. The average contents of N, P, K, Ca and Mg (%) in basil leaves dry matter according to treatments

Treatment[a]	N	P	K	Ca	Mg
1	3.0	0.6	6.9	0.67	0.45
2	1.9	0.6	5.2	0.69	0.39
3	2.9	0.7	8.1	1.07	0.61
4	2.5	0.7	4.3	1.52	0.47
5	2.8	0.6	3.6	1.50	0.68
P	*	NS	***	***	**
LSD (P = 0.05)	0.01	0.03	0.02	0.02	0.04

Used signs: *** P <0.001; ** P <0.01; * P <0.05; NS not significant, P >0.05.
[a] 1 – 30% vermicompost, peat, sand and if needed dolomite stone; 2 – 25% vermicompost, peat, gravel, perlite; 3 – 25% vermicompost, peat, gravel, light gravel; 4 – Locally available, proprietary growth substrate, 5 – 20% vermicompost and organic matter rich clay soil).

Discussion

In present investigation the growth of basil plants in vermicompost containing substrates were enhanced: shoot and root lengths and numbers of leaves increased compared to control (commercially available substrate). The reason can be that vermicompost contains a high proportion of humic acids, fulvic acids and humin which provide numerous sites for chemical reaction; microbial components known to enhance plant growth and disease suppression through the activities of bacteria, yeast (*Sporobolomyces* and *Cryptococcus*) and *Trichoderma*, and the chemical antagonists phenols and amino acids (Theunissen *et al*., 2010). Differences in growth were attributed mainly to differences in nutrient content of the potting mixes, but some changes in physical and biological properties of the substrate could also be responsible (Tringovska, Dintcheva, 2012). Vermicompost has been reported to increase seed germination, stem height, number of leaves, leaf area, leaf dry weight, root length, root number, total yield, number of fruit/plant (Joshi *et al*., 2015).

Vermicompost based substrates have positive effects on plant nutrition as was seen in present investigation by nitrogen and potassium elements, which therefore can have positive effects on plant nutrition, photosynthesis, and chlorophyll content of leaves (Theunissen *et al*., 2010). Vermicompost used as a source of organic material to supplement chemical fertilizer has been found to increase crop yield and nutrient uptake (Vijaya, Seethalakshmi, 2011). Organically grown vegetables, especially where vermicompost has been used, have increased levels of protein, minerals, vitamins and antioxidants than their counterparts grown of synthetic fertilizer (Sinha, 2012). Vermicompost increase nutritional quality of some vegetable (Adhikary, 2012). Vermicompost appears to be beneficial for horticultural production without synthetic chemicals (Sinha *et al*., 2013) and this is the case for basil.

Vermicompost contains plant nutrients including N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu and B, the uptake of which has a positive effect on plant nutrition, photosynthesis, the chlorophyll content of the leaves and improves the nutrient content of the different plant components (roots, shoots and the fruits). Therefore, plants in present investigation had enhanced growth. The high percentage of humic acids in vermicompost contributes to plant health, as it promotes the synthesis of phenolic compounds such as anthocyanin's and flavonoids which may improve the plant quality and act as a deterrent to pests and diseases (Theunissen *et al*. 2010).

According to our results of growth enhancement by using vermicompost in growth substrates, other authors explain it theoretically as following. Vermicompost is made up primarily of C, H and O and contains nutrients such as NO_3, PO_4, Ca, K, Mg, S and micronutrients which exhibit similar effects on plant growth and yield as inorganic fertilizers applied to soil. Similarly, vermicompost contains a high proportion of humic substances (that are: humic acids, fulvic acids and humin) which provide numerous sites for chemical reaction; microbial components known to enhance plant growth and disease suppression through the activities of bacteria (*Bacillus*), yeasts (*Sporobolomyces*) and *Cryptococcus*) and fungi (*Trichoderma*), as well as chemical antagonists such as phenols and amino acids (Theunissen *et al*., 2010).

The discussion about vermicompost influence on plants growth and quality can be concluded in following way: Earthworms and vermicompost can boost horticultural production without agrochemicals. It will provide several social, economic and environmental benefits to the society by way of producing "chemical-free" safe, "nutritive and health protective" (rich in minerals and antioxidants) foods (even against some forms of cancers) for the people; salvaging human wastes and replacing the dangerous "agrochemicals" from the face of earth. The use of vermicompost in farms also "sequester" huge amounts of atmospheric carbon (assimilated by green plants during photosynthesis) and bury them back into the soil improving the soil fertility, preventing erosion or compaction and also reducing greenhouse gas and mitigating global warming (Sinha *et al*., 2013).

Conclusions

Based on the results of the experiments the best substrates to grow basil were 1 (30% vermicompost, peat, sand, dolomite stone) and 3 (25% vermicompost, peat, gravel, light gravel).

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Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Author contributions

MO contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript.

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